Radiation Physics Note 42

BONNER SPHERE DENSITIES

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Introduction

Sets of Bonner spheres are used at Fermilab to determine neutron energy spectra. Polyethylene from which Bonner spheres are made may be either "high density" (0.95 g/cm^3) or "low density" (0.92 g/cm^3). The laboratory presently has two sets of spheres, one of each density.

Density Determinations of Bonner Spheres

During the summer of 1983 two different density sets of polyethylene Bonner spheres were assembled from a collection of spheres purchased several years ago. The spheres were transferred from storage at Site 67 to the Village Machine Shop where their diameters were measured by a machinist using the appropriately sized micrometer.

Each sphere had a cylindrical hole extending from its surface to a point 7/32" beyond the center of the sphere. Polyethylene rods of 11/16" diameter were cut and machined to fit into each hole. Two holes were bored into the end of each rod to hold stacks of four thermoluminescent dosimeters (one stack of TLD 600's and one stack of TLD 700's). A polyethylene cover screwed onto the end of the rod to hold the TLD's in place. These rods are stored at 14 Shabbona.

In order to calculate the density of the spheres the volume and the mass of the polyethylene are needed. The volume of the polyethylene is the volume of the sphere minus the volume of the cylindrical cavity and its end cap. The depth and diameter of the cylindrical hole were measured and with the diameters of the spheres the volumes of the polyethylene were calculated.

The masses of the smaller spheres were found by using a calibrated single pan balance. The masses of the 18" diameter spheres (over 100 lbs) were obtained by placing each one on a postal scale at Site 38 (Receiving). The densities were then calculated from the appropriate masses and volumes (See Table 1).

High density (approximately 0.95 g/cm^3) and low density (approximately 0.92 g/cm^3) sets of spheres, including 2", 5", 6.85", 8", 10", 12", and 18" diameters are from the old collection. Low and high density 3" diameter spheres, together with TLD holder rods, were purchased from Ludlum Measurements of Sweetwater, TX. to complete the sets. The Bonner sphere sets are usually stored at Site 68.

TABLE 1. BONNER SPHERE DENSITY MEASUREMENTS

	Lo DENSITY				HI DENSITY			
NOMINAL DIAMETER (IN.)	SPHERE NAME	DIAMETER (IN.)	MASS (g)	DENSITY (g/cm^3)	SPHERE NAME	DIAMETER (IN.)	MASS (g)	DENSITY (g/cm^3)
18	1	$18.09 \pm .05$	46,437.3	.916	2	$18.11 \pm .02$	48,762	.957
12	MESON LAB	$12.12 \pm .01$	13,967	.916	13	$12.00 \pm .03$	14,129	.956
10	17	$10.02 \pm .01$	7,893	.916	5	$10.03 \pm .05$	8,280	.960
8	6	$8.04 \pm .02$	4,105.5	.926	14	$8.06 \pm .02$	4,281	.957
7					BS-7A	$6.906 \pm .005$	2,678	.954
6.85	7	$6.85 \pm .03$	2,500	.915	8	$6.84 \pm .06$	2649	.970
5	12	$5.01 \pm .01$	984	.924	9	$5.04 \pm .005$	1040	.958
3	WHITE	$2.991 \pm .004$	201.0	.913	TAN	$2.988 \pm .006$	207.3	.945
2	DIRTY 2"	2.00	55.82	.910	CLEAN 2"	2.03	61.65	.945
				$\bar{\rho}_{Lo} = .917 \pm .005$				$\bar{\rho}_{HI} = .956 \pm .007$